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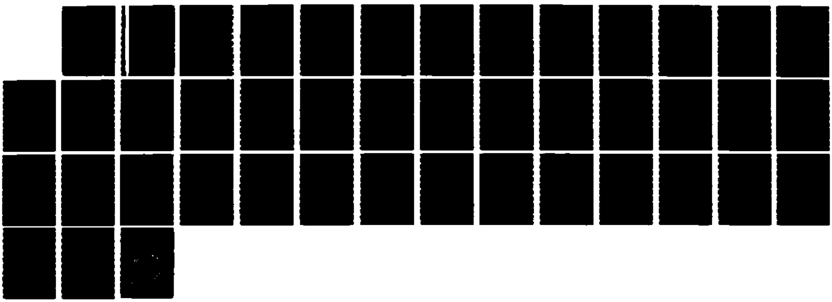

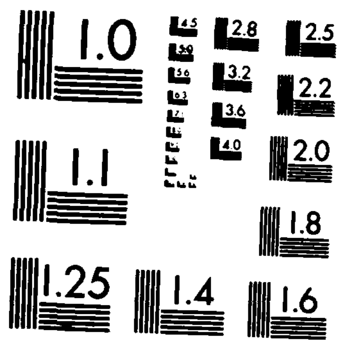

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Structures Technical Memorandum 446

THE LOAD SEQUENCE CONTROLLER FAMILY AN OPERATORS MANUAL

by

I. POWLESLAND and E.S. MOODY

Approved for public release.

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SUMMARY

Information pertinent to the proper operation of the programmers, controllers and data acquisition modules of this instrumentation family, developed specifically for the durability testing of material coupons and aircraft components, is given. The software commands available for system testing, and the procedures for setting and monitoring applied loads are included.

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CONTENTS

1. INTRODUCTION

The advent of the micro-computer, and in particular its application to test and control instrumentation has resulted in the development of many highly sophisticated measuring instruments and controllers able to perform a very wide range of functions. In most cases the range is so wide that without recourse to appropriate manuals the average operator is unable to take advantage of more than a small percentage of the facilities available.

While the family of micro-computer based instruments covered by this manual are essentially single purpose devices in the sense that each has been designed to perform a particular task, the full potential of their ability to perform these tasks will only be realized if careful attention is paid to the procedures discussed in ~~the~~ manual, following pages.

The family of instruments covered by this manual comprises:

1. Single channel load sequence programmers used to generate the load sequence signals to be applied to the input port of a servo-hydraulic testing machine.

2. Single and dual channel controllers which, in addition to providing the load sequence signals, control the loads being applied to the test specimen by including a servo-hydraulic controller and manual valve controls.

3. Eight-input data acquisition modules able to measure and store responses induced in the test specimen by the applied load sequence.

Buried in each of these instruments is a 16-bit micro-computer supported by a primitive disk operating system and application program in PROM. The monitor commands available in the operating system are particularly useful in the setting-up of the instruments prior to a test, and in the diagnosis of faults in the system when a malfunction occurs. These monitor commands are discussed in some detail in the section on the Load Program Module. Further details on hardware design and application software can be found in The Single Channel Test Controller (Ref. 1).

2. THE SINGLE CHANNEL STAND-ALONE PROGRAMMER

CONTENTS

2.1. The Load Programmer System

The system is a single module plus teletype, and functions as a load sequence signal and test log generator only. It is for use with testing machines having their own servo-hydraulic facilities. It may be used with a Data Acquisition module when required.

Care is necessary when interfacing the programmer with the testing machine to ensure earth loops do not give rise to an unacceptably high sensitivity to spurious supply transients.

The load sequence to be generated is represented by turning point values stored on a floppy disk. The maximum value stored is arranged to produce an output voltage from the programmer of about ± 5 volts or a little less. The span control of the testing machine should be adjusted to set the maximum signal voltage equal to the maximum load required.

Before connecting the programmer to the testing machine the output of the programmer should be examined on an oscilloscope to verify proper operation, and the first runs with an active testing machine should be made with a dummy specimen.

2.2. Starting the Programmer

Ensure the connection to the testing machine is open or the span control is turned to zero. The teletype or other terminal should be connected to the TTY port at the back of the programmer and set to the specified baud rate (usually 300 baud). Make sure the load disk is not in the drive.

Note: Disk drives should be disengaged prior to the application or removal of power (lever horizontal).

Apply mains power, insert disk if necessary and engage drive (by turning lever to vertical position) (see 2.4).

With power on and a disk mounted the system is initialized by pressing the RESET button. This button is located behind the hinged front panel of the programmer.

Once the microcomputer is reset an introductory message is printed on the teletype. This message gives some information about the system and is followed, if all is well, by a print-out of the program header for any disk now mounted in the drive. Instead of the header one of two alternative fault messages may be printed out at this time. The faulty conditions indicated are:

a. Failure of the battery supplying the memory. If this occurs Instrumentation personnel must be consulted.

b. Failure of the system to read the load program disk. If this occurs make sure a disk has been inserted in the drive and then refer to section 2.3.

If everything is in order the system advises the operator of the responses that may be given and then asks for confirmation or rejection of the current disk.

2.3. Selecting the Required Load Sequence Program

Loading commands for the programmer are recorded on floppy disks and reference should be made to the attached notes (Appendix 1) on the care and handling of these disks. Improper handling will result in poor performance. The load sequences on the floppy disks are strings of numbers, each representing and being proportional to a particular load command for a particular load turning point value. Here-after these numbers are loosely referred to as turning-point load values.

All the turning point values on one disk make up one load sequence program. Each disk will contain only one load program. Each program is sub-divided into a number of blocks of turning points and, following past practice, these blocks are referred to as "Flights". Each program starts with a program header, mentioned in section 2.2 which contains the following information:

a. The program identifying number.

b. The size of the maximum excursion in the program.

c. The program type number (eg. Type 4X programs are constant amplitude).

d. The span number which is used by the system for automatic load range testing.

e. The number of flights in the program.

f. The average number of turning points in a flight.

Each flight starts with a flight header which contains the following information:

a. The sequence number of the flight in the program. The first flight has the number Ø.

b. The number of turning points in the flight.

c. A flag to be used when environmental control is required.

For more detail on disk formats see Ref. 1.

As an aid to the identification of the required program disk some of the program header information is repeated in a label on the protective jacket of the floppy disk. An opportunity to change the disk if the wrong one is accidentally selected is provided in the start-up sequence of the system. However excessive handling of the disk is detrimental and labels should be read carefully.

The floppy disk proper must <u>never</u> be removed from its protective jacket.

2.4. Load the Selected Disk in its Jacket into the Disk Drive

Access to the load programmer disk drive is obtained by raising the hinged cover of the programmer module.

With the disk clamping lever horizontal, insert the edge of the disk jacket remote from the label into the disk drive slot. The disk label must be on the upper surface of the jacket which must be held square with the front face of the drive. The disk should be pushed firmly into the drive until the back edge of the disk jacket is within, and parallel to the drive face. Lock the disk into the drive by rotating the clamping lever clockwise into a vertical position.

2.5. Disk Problems

If the system is unable to read the disk the operator should remove it from the drive, re-insert it, reset the system using the RESET button and try again. If, after two or three attempts the system is still unable to read the disk it should be assumed the disk is faulty. The assistance of instrumentation personnel should be requested.

If, having read the header print-out, the operator decides the disk is not the one required the response to the system question should be 'N' followed by a Carriage Return. The unwanted disk should be removed, the correct one inserted and the RESET button pressed to start again.

To remove a disk from the drive re-open the hinged cover, rotate the clamping lever anti-clockwise into the horizontal position and withdraw the disk in its jacket without bending it. The new disk should be installed as previously described. After clamping the disk make sure the hinged cover is closed to minimize the entry of dust.

When the RESET button is pressed the system will print all messages including the header for the new disk, and the process can be repeated any number of times until the correct disk is found. However, as mentioned earlier, a careful reading of the disk label will save time, effort and the risk of damage to the disk.

2.6. The Interactive Start-Up Sequence

With the required load sequence found and properly installed in the disk drive the remaining parts of the start-up sequence are automatic. The operator should respond to commands and questions as they occur although the system will wait indefinitely for the operator's response through most of the start-up sequence. Once hydraulic power has been applied to the rig the operator's available response time is reduced to about 5-1Ø seconds.

The following points should be noted:

a. In the print-out and in the following notes, CR is used as an abbreviation of Carriage Return, or simply Return.

b. If the data acquisition module (DAM) is not installed do not ask for data logging.

c. If a Start (S) is requested, any information about the preceding run, particularly the turning point and flight at which it terminated, will be lost. When S is used the system clears the relevant counters and the next run will start at turning point Ø , in flight Ø of the first program pass.

   If it is necessary to stop anywhere but at the end of a program, and the operator wishes to continue from that point when restarting, the Continue (C) command should be selected.

d. The programmer will ask if the hydraulics are on the testing machine, and at this time the testing machine should be under full servo-hydraulic control with hydraulic pressure applied and controlling zero load. When the operator is satisfied the testing machine is ready to run he should respond to the question with Y CR. Beyond this point the operator must respond to the system within 5-1Ø seconds to avoid an automatic system shut-down requiring a restart from the beginning of the sequence.

The operator must elect either to begin load cycling (GO), to begin one load excursion and hold at the first turning point (HD), or to ask the system to wait (WT). The keyboard inputs for these responses are "GO CR", "HD CR" and "WT CR" respectively. Remember the time limit.

2.7. Using the HD and WT Responses

The HD response permits the operator to step the system through the load sequence from turning point to turning point. At each turning point the status with turning point number is printed and a further response from the operator is requested. If the operator requests a WT the system will stay at the turning point reached indefinitely. This response is used when the specimen must be examined under static load, or when a static specimen calibration is required.

Generally the WT response is given after a HD, but it may be given at the outset if some adjustment to the specimen or rig must be made with pressure available to the loading frame. In all cases the action of the WT response is to inhibit the automatic shut-down which otherwise follows less than 10 seconds after a response is requested.

The WT condition is terminated if the operator types GO CR or HD CR and the system will respond without further request for input.

2.8. Ending a Loading Run

Load cycling can be stopped momentarily by depressing any single key on the terminal. Cycling will resume some 1Ø seconds later.

There are two special cases involving the use of the H and T terminal keys:

a. If the operator types H or HD followed by CR the system will hold at a turning point and print a log.

b. If the operator types T followed by a flight number, followed by CR the system will hold momentarily but resume on receipt of the CR. The flight number must be equal to or greater than the flight currently being applied, and less than or equal to the last flight in the program. The system will cease cycling when it has completed the flight specified by this number.

In both (a) and (b) a system log followed by the standard command list is printed. If the operator does not type a new command within approximately 5 seconds the system will shut down automatically.

2.9. Stopping the System in an Emergency

In the event of a specimen failure, or other condition which stops the testing machine it is important to stop the programmer if a true log of the test is to be maintained. This is done by applying a signal to the latch interrupt line, causing the programmer to branch to a "latch trip" routine. A suitable signal must be available in the testing machine, and a suitable isolating interface with a TTL output must be provided. This routine shuts down the programmer and prints a progress log. The log includes a statement of the load command at the instant of failure.

Alternatively the signal generating process may be stopped by pressing the programmer's RESET button. However under these conditions no log is printed.

2.10. Response Timing

The operator should not attempt to anticipate the system; responses to system requests should be made only after the requests have been fully printed on the teletype.

Once a halt has been requested the operator should make no further requests until all output statements are completed.

2.11. Test Progress Reports

Test status reports are made on the teletype as follows:

a. At the completion of each flight in the load sequence program the system will print "End of Flight" followed by the following additional data:

   The number of turning points in the flight.

   The sequence number of the completed flight.

   The number of completed passes through the load program.

   The time and the date.

b. When the end of flight also corresponds to the end of program the above print-out is followed by "End of Program".

c. A similar message is printed when the system holds at a turning point, but in this case the number of the particular turning point is also given.

2.12. Continuous Operation

When a flight is finished and the end of flight message printed the system proceeds automatically to the next flight. When all the flights in the program are completed the system will clear its turning point and flight counters, increment its program counter and re-start the sequence from turning point Ø, flight Ø.

2.13. Monitors, Controls and Indicators

Programmer controls are minimized, the RESET button and the disk loading lever are both behind the front panel and there is no separate on-off switch. To start apply power, load the disk and press the RESET button, then use the terminal to respond to system messages.

When starting the system for the first time the constants stored in battery-backed RAM should be checked and changed as necessary. This is done by transferring the terminal from the TTY port (or Console port) at the back of the module to the test port which is located under the front panel. With the terminal connected to the test port press the RESET button and after a few seconds type 'X'. The system should respond with '#' indicating the system monitor is now available to the operator.

Refer to section 5.2 for details of the commands available.

3. THE SINGLE AND DUAL CHANNEL STAND ALONE CONTROLLERS

CONTENTS

Warning These controllers employ closed-loop, negative feedback configurations to provide accurate load control. If the loop is incorrectly connected, or accidentally broken; or if the hydraulic lines are improperly connected, the test specimen may be destroyed and the operator placed in jeopardy.

3.1. The Load Controller System

The controller consists of 3 or 6 rack-mounted modules and one teletype or similar operator's terminal. The dual system is effectively 2 single channel systems, the Master and Slave controllers, appropriately interconnected.

The modules of a single controller are:

a. Rig Monitor Module with digital voltmeter and servo amplifier.

b. Load Program Module with 8-inch disk drive.

c. Hydraulics Module with Power and Solenoid-valve controls.

The teletype is connected to the TTY port of the Load Program Module or, in the dual channel controller, to the TTY port of the Master Load Program module.

Before the controller system can be used it must be carefully connected, and amplifier gains etc. properly adjusted. For details of these procedures, which should be carried out by instrumentation personnel, refer to "Setting Up the System", section 3.15.

Once satisfied the system has been properly set up the operator should proceed as set out in the following paragraphs.

3.2. Starting the Controller

First ensure the power switch on the controller is Off, then confirm that both electrical and hydraulic power are available to the system. This usually requires the turning on of a 240 volt wall switch, and opening a valve to the hydraulic ring main.

A single switch, located to the left of a large red emergency-stop button, and labelled POWER is used to activate the system. Depress this switch and check that a light emitting diode (LED) indicator immediately above the switch is illuminated. A second LED directly above the first, and labelled M/SWITCH should also turn on at this time. This second LED indicates that any travel-limit switches or emergency stop buttons associated with the rig are in a "Ready-to-run" condition.

Turning on the 240 volt power will apply bridge power to the load cell and cause the microcomputer to reset. This, in turn, disables the control circuits of the hydraulic-supply solenoid valves thereby ensuring hydraulic power cannot be applied inadvertently to the rig at this time.

These systems may incorporate specimen protection where-by a latch trip, or other emergency shut-down will hydraulically lock the loading actuator. This can result in considerable mechanical load remaining on the specimen. To ensure any load of this nature is removed before a restart the operator must press the ACTUATOR RELEASE button as soon as electrical power has been applied to the system. The ACTUATOR RELEASE is located on the Hydraulics Module.

To give the system power supplies and the load cell time to stabilize ignore any terminal activity for about 1Ø minutes. While waiting the actuator should be released and an appropriate loads disk mounted in the disk drive. Disks should be inserted in, or removed from disk drives only when system power is on. Disks should not be mounted when power is removed.

With a disk in the drive and warm-up completed press the RESET button to re-initialize the system. The small red RESET button is located on the Rig Monitor Module in a row of LEDS.

With the dual controller power will need to be applied to both hydraulic modules. Generally the power switch for the Slave controller can be left in the 'on' position and the Master controller power switch will then control power to both.

When the Reset button on a Master controller is pressed both Master and Slave controllers will reset. Only the Slave controller resets when the Slave reset button is pressed.

Once the microcomputer is reset an introductory message is printed on the teletype. This message gives some information about the system and is followed, if all is well, by a print-out of the program header for any disk now mounted in the drive. Instead of the header one of two alternative fault messages may be printed out at this time. The fault conditions indicated are:

a. Failure of the battery supplying the memory. If this occurs instrumentation personnel must be consulted.

b. Failure of the system to read the load program disk. If this occurs make sure a disk has been inserted in the drive and then refer to section 3.

If everything is in order the system advises the operator of the responses that may be given and then asks for confirmation or rejection of the current disk.

In a dual controller system errors detected in the Master controller will be handled as above. Errors in the Slave controller, because it has no terminal for a printed message, must be reported in a more indirect way.

When the Slave controller detects a fault - the only outward indication is the turning on of its Reset led. At the same time the Slave controller will have set one of six flags in its RAM message.

To examine these flags and determine the source of the fault it is necessary to transfer the terminal from the TTY port of the Master to the Test port of the Slave controller and press the Reset button of the Slave. After a few seconds call the Slaves's Monitor routine by typing an 'X' on the keyboard and receive the Monitor's prompt '#' in reply. The Monitor's command 'AM' can then be used to examine the error flags. Their addresses and functions are as follows:

$3Ø2_{16}$	RAM Supply Error
$3Ø4_{16}$	Latch is tripped
$3Ø6_{16}$	Disk Reading Error
$3Ø8_{16}$	Turning Point Error
$3ØA_{16}$	Flight Count Error
$3ØC_{16}$	Flight Header Error

With the exception of $3Ø4_{16}$ there are software errors. $3Ø4_{16}$ may be set alone if the hardware brings about the interrupt, but in all cases of software initiated shutdown $3Ø4_{16}$ and at least one other flag would be set.

3.3. Selecting The Required Load Sequence Program

Reference should be made to Section 2.3 of this manual. These notes are applicable to all load sequence disks.

Where a dual channel controller is involved care is needed to ensure the load sequence disks are a matched pair with each load value point in the Master sequence having a corresponding load value in the Slave sequence.

The Master controller will react to the environmental flags in the flight header of a load sequence if it is set; the Slave ignores this flag but follows the Master.

Automatic calibration is applied to both Master and Slave controllers, and appropriate selection of values for span words will help to ensure the load disks are used appropriately.

3.4. Load The Selected Disk In Its Jacket Into the Disk Drive

Access to the Load programmer disk drive is obtained by raising the hinged cover of the Load Program Module.

With the disk clamping lever horizontal, insert the edge of the disk jacket remote from the label into the disk drive slot. The disk label must be on the upper surface of the jacket which must be held square with the front face of the drive. The disk should be pushed firmly into the drive until the back edge of the disk jacket is within, and parallel to the drive face. Lock the disk into the drive by rotating the clamping lever clockwise into a vertical position.

Remembering that disks should be mounted in, and removed from drives only when electrical power is on; both the disk for the Master and that for the Slave controller should be inserted at this time.

3.5. Disk Problems

If the system is unable to read the disk the operator should remove it from the drive, re-insert it, reset the system using the RESET button and try again. If, after two or three attempts the system is still unable to read the disk it should be assumed the disk is faulty. The assistance of instrumentation personnel should be requested.

If, having read the header print-out, the operator decides the disk or disk pair for a dual controller, is not the one required the response to the system question should be 'N' followed by a Carriage Return. The unwanted disk, or disks, should be removed, the correct ones inserted and the RESET button pressed to start again.

To remove a disk from the drive re-open the hinged cover, rotate the clamping lever anti-clockwise into the horizontal position and withdraw the disk in its jacket without bending it. The new disk should be installed as previously described. After clamping the disk make sure the hinged cover is closed to minimize the entry of dust.

When the RESET button is pressed the system will print all messages including the header for the new disk and the process can be repeated any number of times until the correct disk is found. However; as mentioned earlier, a careful reading of the disk label will save time, effort and the risk of damage to the disk.

3.6. The Interactive Start-Up Sequence

With the required load sequence found and properly installed in the disk drive the remaining parts of the start-up sequence are automatic. The operator should respond to commands and questions as they occur although the system will wait indefinitely for the operator's response through most of the start-up sequence. Once hydraulic power has been applied to the rig the operator's available response time is reduced to about 5-1Ø seconds.

The following points should be noted:

a. In the print-out and in the following notes, CR is used as an abbreviation of Carriage Return, or simply Return.

b. If the data acquisition module (DAM) is not installed don't ask for data logging.

c. If a Start (S) is requested, any information about the preceding run, particularly the turning point and flight at which it terminated, will be lost. When S is used the system clears the relevant counters and the next run will start at turning point Ø, in flight Ø of the first program pass.

   If it is necessary to stop anywhere but at the end of a program, and the operator wishes to continue from that point when restarting, the Continue (C) command should be selected.

   For dual controllers it is very important to ensure the load cycles of Master and Slave remain in step. Therefore, when the operator proposes to request Continue (C) during Start up, the turning point counter ($1Ø34_{16}$) and the flight counter ($1Ø22_{16}$) should be checked for correspondence in both Master and Slave. These checks are made by transferring the terminal to the Test port and using the Monitor command 'AM'.

d. Do not turn on the hydraulics until satisfied that everything is ready for load cycling to begin. Beyond this point the operator must respond to the system within 5-1Ø seconds to avoid an automatic system shut-down requiring a restart from the beginning of the sequence.

3.7. Hydraulic Power And Specimen Loading

Before the system gives the command "Turn on Hydraulics" it enables the circuits of the solenoid valves, disabled during initialization, and turns on a LED on the Hydraulics half module to tell the operator these circuits are ready.

To apply hydraulic power the operator must press in turn the "Dump-Run" button followed by the "Supply On" button and then the "HP On" button. The LED in each button will be illuminated as the corresponding valve is energized.

Valves are de-energized by pushing the corresponding red button.

Note the following:

a. If the "Dump-Run" valve is de-energized the "Supply On" and "HP On" valves will de-energize automatically. Similarly if "Supply On" is de-energized "HP On" will de-energize automatically.

b. If the "Dump-Run" valve is energized the "Actuator Release" valve will energize automatically.

The system will wait indefinitely for the operator to energize the control valves, but as soon it senses hydraulic power it switches from start-up to loading mode and prints a number of electives for the operator. From completion of this print-out the operator has about 5-1Ø seconds to input a response.

The operator must elect either to begin load cycling (GO), to begin one load excursion and hold at the first turning point (HD), or to ask the system to wait (WT). The keyboard inputs for these responses are "GO CR", "HD CR" and "WT CR" respectively. Remember the time limit.

Some hydraulic control circuits have required a change in the switching arrangement from that described above. Only three press buttons labelled respectively "Rig Pressure", "Unload" and "Off" are required. In this case "Unload" is the equivalent of "Actuator Release".

To apply hydraulic power the operator must press "Rig Pressure" only.

In dual controller systems both controllers have their own hydraulic modules but the controls on the Slave module, if available, are redundant. The Slave Hydraulic module is required only to supply electronic power for that controller.

3.8. Using The HD And WT Responses

The HD response permits the operator to step the system through the load sequence from turning point to turning point. At each turning point the status with turning point number is printed and a further response from the operator is requested. If the operator requests a WT the system will stay at the turning point reached indefinitely. This response is used when the specimen must be examined under static load, or when a static specimen calibration is required.

Generally the WT response is given after a HD, but it may be given at the outset if some adjustment to the specimen or rig must be made with pressure applied to the loading frame. In all cases the action of the WT response is to inhibit the automatic shut-down which otherwise follows less than 1Ø seconds after a response is requested.

The WT state is terminated by the operator typing HD CR, which results in a single excursion, or GO CR which leads to continuous load cycling. Alternatively the typing of any character followed by a CR will bring about a re-statement of the alternative commands.

These comments apply to both single and dual channel controllers.

3.9. Ending A Loading Run

In normal situations load cycling can be stopped momentarily by depressing any single key on the terminal. Cycling will resume in about 10 seconds.

There are two special cases involving the use of H and T terminal keys:

a. If the operator types H or HD followed by CR the system will hold at a turning point and not resume.

b. If the operator types T followed by a flight number, followed by CR the system will hold momentarily but resume on receipt of the CR. The flight number must be equal to or greater than the flight currently being applied, and less than or equal to the last flight in the program. The system will cease cycling when it has completed the flight specified by this number.

In both a. and b. a system log followed by the standard command list is printed. If the operator does not type a new command within approximately 5 seconds the system will shut down automatically.

These comments apply to both single channel and dual channel controllers.

3.10. Stopping The System In An Emergency

The single and dual channels controllers incorporate a Fault Latch system which can be tripped by external micro switches, by tripping the Excess Error and Excess Load Limit circuits, or by the operation of the Emergency Stop Button. When this latch is tripped the hydraulic supply is turned off, and the microcomputer is switched by interrupt to a "latch trip" routine. This routine disables the hydraulic switching circuits thereby preventing a premature re-start, and prints a message containing a statement of the load command value at the time of the interrupt.

In dual channel controllers only the load command value for the Master controller is printed out when the interrupt occurs.

Alternative methods for stopping the system are:

a. Turn off the hydraulics using the hydraulics - off button. This will cause the system to stop on a null error at the next turning point and give rise to a test log.

b. Either press the reset button or turn off the electrical power to the system. These techniques are not recommended because a test log is not printed and there is no record of the load command.

3.11. Response Timing

The operator should not attempt to anticipate the system; responses to system requests should be made only after the requests have been fully printed on the teletype.

Once a halt has been requested the operator should make no further requests until all output statements are completed.

3.12. Test Progress Reports

Test status reports are made on the teletype as follows:

a At the completion of each flight in the load sequence program the system will print "End of Flight" followed by the following additional data:

The number of turning points in the flight.

The sequence number of the completed flight.

The number of completed passes through the load program.

The time and the date.

b. When the end of flight also corresponds to the end of program the above print-out is followed by "End of Program".

c. A similar message is printed when the system holds at a turning point, but in this case the number of the particular turning point is also given.

3.13. Continuous Operation

When a flight is finished and the end of flight message printed the system proceeds automatically to the next flight. When all the flights in the program are completed the system will clear its turning point and flight counters, increment its program counter and re-start the sequence from turning point Ø, flight Ø.

3.14. Monitors, Controls and Indicators

All controls should be handled with care, and the monitors should be used regularly to check the state of the system.

a. Servo-Amplifier Controls. The operator should avoid making adjustments to these controls. With hydraulic power on and the system in a WT state the Set-Point control can be used to move the machine heads for mounting and removal of test specimens. However this practice is dangerous and therefore NOT RECOMMENDED, and if used great care must be exercised, particularly where large capacity servo-valves are used with low volume actuators. All other controls on the servo-amplifier should be regarded as pre-sets and adjusted only after consultation with instrumentation personnel.

b. Servo-Amplifier Monitors. The important monitors are the null indicating LED, and the error-limit and load limit indicator lamps.

c. SAC Rig Monitor Module. This module has two types of indicator LEDS for state indicators, and a digital meter for analogue signals.

When the system is ready for reset and restart the RESET LED will be on.

When the monitor bridge signal is equal to the command signal the MONITOR NULL LED will be on.

When the control bridge feedback signal and the command signal are equal the FB NULL LED is on.

When an excursion command is completed the system loop integrator is operating the DWELL LED is on.

During initialization, when the system is checking the control load range, the CAL LED will be on.

The digital panel meter has a selector switch input and a fixed voltage range of ±20 volts. It can be used to measure any suitable external voltage or any one of the following system parameters:

The controller command voltage in volts.

The monitor bridge output after a fixed amount of amplification, in volts.
The control bridge output after a fixed amount of amplification, in volts. Small differences between this reading and the previous reading would result from different initial offset values.

Valve current. To obtain true valve current in milli amps multiply the meter reading by 1Ø.

Error voltage. This is an amplified version of the output of the control loop summing junction, in volts.

Feedback. This is the control bridge voltage above with some additional amplification to meet scaling requirements.

d. Other Indicators. In addition to the Monitor Module LEDS there are three LEDS and four illuminated press buttons for solenoid valve control on the Hydraulics Module.

The power panel LEDS are used to indicate:

System power is on.

External travel limit, and emergency stop buttons are all in the "Ready-to-run" state.

The single LED on the hydraulic panel is on when the solenoid valve circuits have been enabled, and the individual press-button LEDS turn on as the associated valve in energized.

3.15. Setting Up the System

These setting-up procedures should be performed only by Instrumentation Personnel. They are appropriate for both single and dual channel controllers, the latter being regarded as two completely independent single channel systems in this instance. The procedures are directed to ensuring the accuracy of the applied loads, the repeatability of the applied loads and the compatibility of the installed load sequence disk with the currently set control loop gains.

It should be recognised that the procedures given in the following sections are not the only ones available for setting up these systems, and in some instances other procedures may be more appropriate. Great care is necessary in the simulation of load cell signals, and in the adjustment of controller gain and controller zero condition.

All of the following adjustments must be made with hydraulic power completely removed from the test rig.

3.16. Simulating Load Signal

To select a value to be set on a precision resistance box which will produce the same output from a load cell bridge as will be output from that bridge when the cell is loaded with a specified load.

a. Take the maximum test load required and round this upwards to the nearest most significant whole number. For example if the maximum load required is 87 kN then select 90 kN.

b. Make sure the maximum load to be applied in a test is not less than 33% or more than 100% of the rated capacity of the cell to be used. In the above example the cell capacity should be less than 270 kN.

c. To achieve the maximum use of the available command range take the maximum command value to be equal to the rounded maximum test load. In this example the 90 kN would be equal to 9.995 volts.

d. Take the load signal to be simulated by the precision shunting resistance box as 80% of maximum test load, ie. simulate 72 kN which will be equivalent of 7.996 command volts.

Before the resistance value required can be calculated the sensitivity and range of the load cell, and the resistance of the bridge arm to be shunted, must be known precisely. The value of the shunt resistance can then be calculated from the formula

$$R = r\left(\frac{L}{4Sx} - \frac{1}{2}\right)$$

where R is the value set on the resistance box.

r is the resistance of the bridge arm shunted.

L is the capacity of the cell - not the maximum test load.

S is the sensitivity of the cell in volts/volt of bridge supply.

x is the load value to be simulated by the shunt.

For the above example if
$r = 350.6$ ohms
$L = 100$ kN
$S = 0.003$ volts/volt
$x = 72$ kN
then R can be calculated to be 40403 ohms.

e. Unless the value of the arm resistance to be shunted is known with some precision the above formula cannot be used.

If the cell sensitivity and the bridge supply voltage are known then the bridge output voltage for full load, or any fraction there-of, can be calculated. With the bridge output displayed on a milli-volt meter adjust the shunting resistance box until the desired output is obtained. It is necessary to ensure the volt meter measuring bridge output does not introduce erroneous signals.

If the sensitivity of the cell is unknown also then a load equal to the maximum test load should be applied to the cell with the selected bridge voltage, and the output measured on a milli-volt meter. The load should be removed and the resistance box connected across an arm of the bridge to give the required polarity of output. Adjust the box to give the same output as the load.

3.17. Feedback and Monitor Zeros

To set feedback and monitor Zero conditions:

a. Make sure there is the appropriate load on the load cell to apply zero load to specimen (ie. rig weight compensated) and check the correct bridge voltage is applied.

b. The zero load output from the bridge can be adjusted to cancel any initial bridge amplifier offset, but as the latter is a function of gain the processes of offset cancellation and amplifier gain adjustment will be iterative.

c. To check the initial offset of the amplifier is within specification note the present gain setting, remove the load cell bridge from the amplifier input and substitute a shorting plug. Display the output of the instrumentation amplifier on the rig Monitor DVM by selecting "Control Bridge" or "Monitor Bridge" as appropriate. The check must be done for both. Note the output voltage, divide it by the gain set and compare the result with the specified input offset voltage. The input offset voltage for the type of instrumentation amplifier used should be less than 200 microvolts.

d. With the amplifier offsets confirmed reconnect the load cell bridges and adjust the offset of these bridges to give an overall offset (bridge plus amplifier) as close to zero as possible. This adjustment is done by shunting one arm of the cell bridge with a resistance box connected to terminal pair R20 or R23 for one bridge, and R26 or R29 for the other (refer to drawings 58386A1 and 58387A1). Once the correct position and resistance value are determined fixed resistors should replace the box.

Note that if necessary the overall feedback amplifier chain can be set to zero by using RV8, the Zero Suppression Trimmer on the front of the servo-amplifier. With the Rig Monitor DVM switched to the "Feedback", adjust RV8 for a zero reading.

There is no zero adjustment for the monitor amplifier.

3.18. Feedback and Monitor Gains

To set feedback and monitor Gain conditions:

a. With approximate zero values of offset achieved on both feedback and monitor channels and with 'command' value set to zero, the first adjustments of gain should be undertaken.

Place the precision resistance box set to the value calculated, or otherwise determined as in 3.16, across the appropriate arm of each load cell bridge in turn and adjust the gain to give the desired voltage. For the example above this should be 7.996 volts plus or minus any residual initial offset.

b. The monitor amplifier chain has 2 adjustments, a coarse gain preset LK4 and a fine gain trimmer RV2 both on the Rig Monitor card. For these adjustments the DVM should be set to 'external' and connected to TP1 at the end of R67 in the Rig Monitor. Measurement is made at this point to ensure proper tracking of command and monitor signals.

c. The feedback amplifier chain has 3 adjustments, LK3 a coarse adjustment in the Rig Monitor, Feedback Gain RV3 and Feedback Trim RV7. RV3 and RV7 are both in the servo-amplifier and RV7 is accessible from the front of that amplifier. The feedback chain output is indicated on the DVM when it is switched to "Feedback", and as before the reading for the example should be 7.996 volts plus or minus any residual initial offset.

d. With gains approximately as required the zero signals should be rechecked and readjusted as necessary. In this case the zeros should be measured at the same points as the overall gains.

When setting feedback and monitor gains it is important to recognize that the maximum gain which can be used is limited by the amplifier chain's input offset stability and noise levels. Currently, for practical purposes, this maximum gain is considered to be about 3000. Within this limitation, there should be sufficient gain to amplify the load cell output for the maximum test load required to the equivalent full scale command voltage value.

3.19. Automatic-Gain-Test Adjustments

To select fixed resistors for use in the automatic gain tests:

a. Using the technique described in section 3.16 calculate a value of R which will simulate about 6Ø% of the maximum load required. The exact load is not important at this point.

b. Select 2 identical (±0.5%), high stability fixed resistors close to the value calculated in (a), and mount them in the appropriate shunt calibrate resistor positions R53-R6Ø of the Rig Monitor Module (refer to drawings 58386A1 and 58387A1) for corresponding monitor and feedback bridges. The unused resistor positions may be used for other test rigs.

c. Accurately determine by measurement the value of the resistor located in the feedback bridge circuit and use this value to calculate:

   1. The percentage of full load simulated when this resistor is shunted across a bridge arm.

   2. The corresponding DAC command expressed as a hexadecimal number.

   The command equivalent to positive full scale load is $7FFF_{16}$ and for a simulated load of 6Ø% full scale the hexadecimal command would be $4CCC_{16}$. Because the DAC accepts the 3 most significant digits only, the fourth digit should be set to zero and the third digit adjusted appropriately, ie. $4CCC_{16}$ to $4CD\emptyset_{16}$.

d. With no load applied to the load cell, and with the command set to zero (AM 8Ø1Ø 'SP' Ø 'SP' where 'SP' represents 'Space") the Set Point control on the servo amplifier should be used to reduce any Error Signal to zero.

e. Switch the 2 resistors selected in (b) across their corresponding bridge arms by using the SB command followed by a number from $1B_{16}$ to $1E_{16}$ depending upon the location chosen for them (refer to Appendix 2). Then apply the hexadecimal command word calculated in (c) to the DAC using AM 8Ø1Ø 'SP' 4CDØ 'SP'. Small adjustments should then be made to the 3rd digit (D in the example) of this word to reduce the Error Signal to zero.

f. When the required hexadecimal command word, with the least significant digit zero, has been determined the appropriate digit from column 3 of the following table must be added to yield the complete word. This word is then converted to an equivalent decimal number for recording in ASCII on the disk. It is important that conversion to decimal is performed only after the number in column 3 has been added.

1 Shunt Resistor Position	2 CRU Bit Number	3 Least Significant Digit
Ø	$1B_{16}$	Ø
1	$1C_{16}$	2
2	$1D_{16}$	4
3	$1E_{16}$	8

g. The complete command word expressed in decimal notation is known as the Span Word. This word is recorded on the load sequence floppy disk as part of the program leader. Further details of the program leader can be found in the Load Disk specification (Ref. 1). To guard against the use of a particular load sequence disk on a controller not set for the load range of that sequence all load disks must carry an identifying Span Word.

3.20. Other Adjustments

With the bridge circuit zeros and amplifier gains set, and with shunt calibration resistors and Span Word determined, the next step requires preliminary adjustments to be made to monitor and feedback null bands.

Reference should be made to the circuit diagram of the rig monitor card (Drawings Nos 58386-A1 and 58387-A1) for details of the monitor null adjustments. There are two adjustments, RV_3 which adjusts the symmetry of the null band and RV_4 which adjusts the width of the band.

For the adjustments to be made to the feedback null circuits, and for all the critical adjustments which must be made to the control and safety circuitry (both before and after hydraulic power has been applied) reference must be made to the Operators Manual of ARL Servo amplifiers (Ref. 2). The procedures set out in this manual must be followed with the utmost care if proper and safe operation is to be achieved.

3.21. Configuring the System

The setting-up procedures described in the previous sections are carried out with the system teletype or other similar terminal connected to the Test port of the Load Program Module. When setting-up is complete the terminal should be transferred to the TTY port of this module or, in the case of a dual system, to the TTY port of the Master Load Program Module.

Similarly the Data Acquisition Module should be connected via its TTY port to the AUX port of the Load Program, or Master Load Program Module.

4. THE DATA ACQUISITION SYSTEM

CONTENTS

4.1. The Data Acquisition System

This system consists of one rack mounted module, a sensor-amplifier terminating box and up to eight sensor amplifier pods. These pods are attached to the test structure with a suitable temporary adhesive, eg. Pliabond.

For static measurement the Data Acquisition System can be used with only a teletype, but for dynamic turning-point measurements and for general applications it must be used with a Load Program Module or computer.

The Data Acquisition Module (DAM) contains a floppy disk drive which is the same as that used in the Load Program Module.

4.2. Connections

Before starting the system the operator should check all connections to the sensor amplifiers and to the sensors. Remember all active sensors amplifiers must be connected consecutively, starting from channel 1, to the input channels of the amplifier terminating box. All unused input channels should be connected to 'Reverse Cal' circuits.

Check the ribbon cable from the DAM to the amplifier terminating box, the individual cables to the amplifier pods and the short cable runs from pods to sensors.

When used with a Load Program Module connect the TTY port on the DAM to the AUX port on the program module.

4.3. Apply Electrical Power to the DAM

This module has its own internal power supply but normally derives 24Ø volts AC from the load controller. Applying power to this unit will apply appropriate power to the associated sensors and sensor amplifiers.

Time is required for sensors and amplifiers to stabilize after power has been applied and this time should be used to mount the appropriate floppy disk in the disk drive. Disks should be mounted when power is on, and removed before power is turned off.

4.4. Reset the DAM

Either at the completion of the warm-up period, or as soon as the floppy disk has been properly mounted the DAM RESET button should be pressed. This button is located on the front of the DAM. Pressing this button initializes the DAM program and starts a search of the disk for the last sector written during an earlier run. New sensor data will be written into the next, and succeeding, sectors. Because this search may take some minutes the operator should make sure the drive has stopped before proceeding further. If the DAM system is to be operated with a teletype only, reference should be made to the system report (Ref. 1). When operating with a program module everything is automatic unless an error is detected within the system.

4.5. Operating Errors

When an error is detected both the Load Program Module and the DAM will stop and the Program Module will shut down.

When the DAM program detects an error it sets an appropriate error flag in memory and turns on an error LED. To identify the error it is necessary to use the teletype. Transfer the teletype from the TTY port at the back of the Load Program Module to the Test port of the DAM. This port is located behind the hinged front cover of the DAM. When the teletype has been connected, but not before, press the DAM RESET button, wait 2 seconds and type 'X' on the teletype to enter the monitor. Once in the monitor, indicated by the printing of the monitor prompt '#', the contents of memory can be examined using the monitor command AM, followed by an even memory address, followed by a space. This sequence will cause the contents of the location addressed to be typed out.

The error flags are in locations $3ØØ_{16}$ to $3ØA_{16}$, and a flag is set when the location contains $FFFF_{16}$. The locations and the corresponding errors which cause the flag to be set are as follows:

$3ØØ_{16}$	A buffer overflow has occurred
$3Ø2_{16}$	The sensors are out of calibration
$3Ø4_{16}$	The disk is full and must be replaced
$3Ø6_{16}$	A disk 'read' error has occurred
$3Ø8_{16}$	A disk 'write' error has occurred
$3ØA_{16}$	Sensor channels are not properly connected - they are out of sequence

In this system disk errors do not cause the hydraulics to be disabled directly although they will be disabled once the system is shut-down.

Under normal circumstances the most frequent cause of error will be a full disk. In this case the disk must be removed and replaced by a properly formatted empty disk.

4.6. Analog Circuit Calibration

(See also Reference 1 and Drawings 59557 A2).

Briefly the shunt calibration circuits with their inherent errors arising from lead effects are not used as the basis for measured parameter calculations. These circuits are employed only to establish the repeatability and integrity of the measuring system; and if the 'cal' signal does not fall within prescribed limits no measurements can be made. This restriction avoided the problem of earlier data acquisition systems where-in the 'cal' irrespective of its value, did not prevent data readings and, when subsequently used to compute the parameter value, could give rise to ridiculous values.

In the present system sensor excitation, sensor sensitivity factor and amplifier gain are assumed constant and provide the basis for making the system direct reading in the parameter being measured. Sensor excitation and amplifier gain can be maintained within small and precisely known limits if reasonable precautions are taken in the design and construction of the circuits. The sensor sensitivity factor, while it is constant, is not known with the same precision as the other factors and contributes the major source of error in this, or any other, system. Fortunately the likely scatter factor is well known. A further factor effecting performance is a variable initial offset but in most modern instillations, particularly for laboratory applications, this variability is small.

4.7. Replacing the DAM Disk

Before a disk can be used it must be appropriately formatted. If the new disk is direct from the store it is unlikely to have been formatted appropriately. The formatting process will destroy any data currently on the disk.

To format the disk first check that the 'write-protect' gap, if present, has been covered by a suitable tag, and then mount the disk in the DAM disk drive. The teletype should be still connected to the DAM test port and the system should still be in the monitor program. This can be checked by pressing the INTRPT key on the teletype (break) to produce the monitor prompt '#'.

Once in the monitor the 'FD' command should be used to call the formatting routine. To the command 'FD' the monitor replies 'FD?'and before responding the operator must be very sure the mounted disk does not contain any useful data. When satisfied the operator should type 'Y'. It is important to appreciate that any data on the disk at the time it is reformatted will be lost with no chance of recovery. When the disk formatting process is complete, in a matter of a few minutes, the teletype should be returned to the TTY port at the back of the program module, and both programme module and DAM should be reset. Wait for the DAM drive to complete initialization before continuing through the start-up sequence.

5. SETTING-UP LOAD PROGRAM MODULE

CONTENTS

5.1. Load Program Module Constants

Before the load programmer can execute its Application Program successfully certain constants, held in battery-supported RAM must be checked and, if necessary, reloaded. The TDOS4 instruction 'AM' is used to load and examine these constants.

Memory locations 1000_{16} to $11FF_{16}$ are in battery-supported RAM. Locations 1000_{16} to 1006_{16} are used to store a number sequence which serves as a check on the condition, and reliability, of this RAM. The sequence is automatically checked against an identical sequence stored in ROM. The sequence should be loaded as follows:

Location	Number
1000_{16}	1111_{16}
1002_{16}	2222_{16}
1004_{16}	4444_{16}
1006_{16}	8888_{16}

Note. Both location and number are expressed in hexadecimal notation.

Location 1008_{16}. The constant entered in this location is used by the system timer to limit operator response time and time for systems to achieve a null. Load this location with $7FFF_{16}$.

Location $100A_{16}$. This constant is used to determine the cycling rate when a particular excursion changes from tension to compression or vice versa. The minimum number to be loaded should be about $3F_{16}$.

Location $100C_{16}$. This constant is used to determine the cycling rate for excursions which do not change sign. The minimum number to be loaded should be about $2F_{16}$.

Location $100E_{16}$. The constant loaded in this location is used by the timer to determine the length of a pause at a load turning point when null monitoring is not used, ie. where the load programmer is used only as a signal generator. The minimum number for this location should be about $3F_{16}$.

Note. All numbers loaded to locations used by the timer, (the 4 locations above), must have a 1 in the least significant digit to permit them to be loaded into the timer.

Location 1014_{16}. To monitor the disk controller's performance this memory location is used as a counter to accumulate the numbers of times it has been necessary to repeat the disk double-read of a sector into RAM. The number of repetitions as recorded in 1014_{16} is a measure of controller performance.

Location $103C_{16}$. The number loaded to this location is a time delay multiplier working with the time interval set in 1008_{16}. With 1008_{16} set at $7FFF_{16}$ and $103C_{16}$ set to $000C_{16}$ a total delay of about 4 seconds is achieved.

5.2. Monitor Commands

Help - HE

The routine provides a printed list of all the facilities available in the package.

Read Disk - RD

This routine reads a specific sector from the disk and transfers the data to RAM starting at a specific RAM address. In response to 'B' the operator must type the number of the sector to be read as a hexadecimal number from Ø to FA3, and terminate with a Carriage Return (CR). The total number of sectors on the disk is determined from the fact that there are 26 sectors in each of 77 tracks on each of the 2 sides giving 4ØØ4 sectors in all.

In response to 'P' the operator must type in a hexadecimal number specifying the start address in RAM where the data of the sector is to be loaded. This address is required to be an even 256 byte address. Which means the address must be, for example, 1ØØ, 2ØØ, 3ØØ, etc hexadecimal. Remember that any program already present in this section of RAM will be destroyed.

After a short interval for reading and transfer of data the system will print a number from ØØØØ to ØØØ3.

If the number is ØØØØ the transfer has been completed satisfactorily.

If the number is ØØØ1 the system has been unable to run the disk and a check should be made to make sure a disk is mounted.

If the number is ØØØ2 a seek error has occurred. Try a system reset and start again.

If the number is ØØØ3 the sector requested has not been found. Try a system reset, but if this fails there could be formatting errors.

Write Disk - WD

This routine will write data to the disk sector specified by the operator in response to the prompt 'B'. The data to be transferred to disk should be taken from a block of 256 bytes of RAM starting from the even hexadecimal address, 1ØØ, 2ØØ, 3ØØ, etc input by the operator in response to the prompt 'P'.

Make sure the mounted disk is not write protected, add the foil tag where this is required.

After a short interval the system will respond with a number from ØØØØ to ØØØ3. These numbers have equivalent meaning to those given for the Read Disk routine.

Format Disk - FD

Great care is necessary in the use of this routine because any data on the disk at the time the routine is called will be automatically and irrecoverably destroyed.

With the most recently available disks it is necessary to attach a write-enable tag before anything can be written on the disk, or anything currently on the disk can be over-written.

This formatting routine will format 8-inch, double-sided, double-density disks to give 26 sectors for each of 77 tracks on each side of the disk. The format is IBM System 34 - 256 bytes per sector.

To reduce the possibility of accidental loss of data the system asks for confirmation whenever it receives 'FD' by printing 'FD?'. To continue the operator should reply the 'Y'. Any other character followed by CR will abort the routine.

Several minutes are required to completely format the disk. When the process is complete the system executes carriage return followed by the system prompt.

Load Disk - LD

This routine is provided for those users who do not have compatible floppy disk systems on their main computers. It permits the transfer of properly formatted loads data from a central computer to a disk in the Load Programmer over an RS-232 link using the limited RAM memory of the Programmer as a buffer store.

The central computer is required to send the loads data 256-byte sector by 256-byte sector, with each sector sent in response to an ASCII 'S' from the Load Programmer.

The RS-232 line must be connected to the AUX port of the Load Programmer, and both central computer and Load Programmer must be set to the same baud rate. The default baud rate for the Load Programmer is 9.6K baud, and if the central computer requires a slower baud rate the Programmer rate an be adjusted to suit by changing the word at memory location $1ØEØ_{16}$ to the required rate number in hexadecimal. For the 9.6K baud default value the number in 1ØEØ is $258Ø_{16}$. LD is not followed by Carriage Return and no prompt is received when the transfer is complete.

Disk Address - DA

This routine permits the operator to establish the current address of the disk heads. In response to 'DA' the system prints 6 numbers each of 2 characters.

The first number is the track number starting from ØØ.

The second number is the side number starting from ØØ.

The third number is the sector number starting from Ø1. This should not be confused with the sector number given in response to 'B' in Read Disk and Write Disk; this is more correctly termed a Block number and it starts from ØØØ.

The fourth number represents the number of characters/bytes per sector. For 256 byte sectors the number is Ø1.

The remaining numbers are cyclic redundancy check characters and may be ignored.

Read Console - RC

There are 3 RS-232 ports on both Load Programmer and Data Acquisition Module. The Test port connector is mounted horizontally on the front of the module, and a terminal connected to this port is used to call TDUS4 routines.

The other two ports are on the back of the module and are labelled TTY and AUX respectively. TTY is the Console port and AUX the Auxiliary port.

When the operator types 'RC' on the Test port terminal the system waits for a character to be input on the Console terminal. Any character input on the Console terminal will be printed on the Test terminal.

Write Console - WC

This routine is similar to RC but will print on the Console terminal any character input on the Test terminal.

Read Auxiliary - RA

As for RC. The character is input at a terminal connected to the AUX port and printed on the Test terminal.

Write Auxiliary - WA

As for RA. A character input on the Test terminal is printed on the terminal connected to the Auxiliary port.

Terminals connected to the TTY and AUX ports must be set to pre-determined baud rates. The systems adjust automatically to the baud rates of terminals connected to Test ports if these rates are less than 4.8K baud but the baud rates of UARTS serving the TTY and AUX ports are pre-set by the software as follows:

TTY port on Load Programmer	- 300 baud or 9.6K baud by TDOS4.
AUX port on Load Programmer	- 9.6K baud.
TTY port on Data Acquisition module	- 9.6K baud.
AUX port on Data Acquisition module	- 9.6 K baud.

Set Bit - SB

This routine sets to 1 or clears to Ø any specific output bit in the Communications Register Unit (CRU). The operator should type 'SB' followed by the bit number expressed in hexadecimal notation followed by 'Space' followed by a Ø or 1 depending upon whether the bit is to be cleared or set, and end with CR.

For this routine all CRU bits are numbered relative to base Ø.

Test Bit - TB

This routine permits the examination of any CRU input bit. The operator should type 'TB' followed by the bit number in hexadecimal followed by 'Space'. The system will then type Ø or 1 depending on whether the bit is cleared or set and follow with a CR and system prompt.

Bits are numbered relative to base Ø.

Set Clock - SC

Both microcomputers have calendar clocks which indicate date (day, month and year) and the time (hours and minutes).

In response to 'SC' the system will type

'DD MM YY - HH MM'.

The operator must insert a character under each letter using leading zeros where necessary. The system repositions the carriage after each entry, and the operator must not attempt to input 'Space' or 'CR'.

DD is for DAY
MM is for MONTH and MINUTES
YY is for YEAR
HH is for HOURS

Time - TI

In response to 'TI' the system will print the current reading of the clock in the format given above with leading zeros retained.

Address Modifier - AM

This routine permits the examination of a word in memory, and the alteration of words in RAM.

The operator should type 'AM' followed by the hexadecimal address of the first memory word to be examined. Because this is a word based routine the address must be an even number. When 'Space' is typed the system will print the contents of that memory location as 4 hexadecimal characters. If 'Space' is again typed the contents of the next memory word will be typed.

If the word in any memory location is to be changed the required contents should be typed by the operator immediately following the printing of the current contents. It is important to remember that the contents will not be changed until 'Space' is typed again. The modified memory content is not displayed and to verify the change required has been achieved the location must be re-addressed.

To exit AM the operator should type either 'CR' or 'Break'.

Cycle - CY

This routine checks the operation of the Digital to Analogue converter of the Load Programmer and the Analogue to Digital converter of the Data Acquisition module. For the Digital to Analogue converter a waveform is generated, and for the Analogue to Digital converter an 8-channel 'Read' is executed with the readings printed on the Test terminal.

The routine assumes both converters are present but runs for either. This continuous routine can only be terminated by pressing the module's RESET button.

Go - GO

'GO' should be followed by a memory address. This routine switches the program counter to the memory address given to begin execution of program code. This routine is useful in program development and system testing when the Test terminal is present but it is not required in a working system.

Load Program - LP

This routine will transfer program or data from a source computer to RAM in either the Load Programmer or the Data Acquisition module over an RS-232 line connected to the module's Test port.

Both computer and module must be operating at the same baud rate, and the data to be transferred must be in the Technico Dump format. This format requires the data to be preceded by a 4-ASCII character address followed by a colon, followed by a Space. The data must be in pairs of ASCII characters separated by spaces, with each pair representing one byte. The address gives the hexadecimal address, including leading zeros, in module RAM at which loading is to start.

The source computer file to be transferred should begin with LP to instruct the module to take the data. Any characters between LP and the 4 ASCII address characters immediately before the colon will be ignored.

The transfer of data will continue until the source computer stops sending, and the data will be stored sequentially in the module. Once the transmission of data is complete the source computer may send a 'Break' command, or the operator may press the module RESET button to recover the system prompt.

Dump Disk - DD

This routine transfers sectors from a floppy disk to the AUX port of the load programmer. Enter the following command on the terminal connected to the Test port of the programmer:

DD'N'

N is a hexadecimal number from 1 to FA3 and specifies the number of sectors to be transferred from the floppy disk to an RS-232 terminal, or computer, attached to the AUX port of the module.

The transfer will always start from the first sector on the disk and continue until the required number of sectors has been output. There is no demarcation between sectors.

The data output at the AUX port will be in ASCII coded hexadecimal, and can be printed as hexadecimal on a printer.

The routine is arranged to accept X-ON and X-OFF signals from the receiving terminal, or computer, to regulate the flow of data.

X-ON is CTRL Q
X-OFF is CTRL S

6. CONCLUSION

Reliability over long periods is a major requirement of all instrumentation used in fatigue testing. To date field experience with the instruments discussed in this manual is insufficient for any general statement of performance to be made but some specific features can be signaled out for comment.

a. For reliable operation the reading heads of the floppy disk drives must be cleaned at regular intervals.

b. It seems a feature of the disk drives used that the head positioning mechanism sometimes sticks in the "track Ø" position. While this problem is acknowledged no satisfactory cure has been suggested other than to move the mechanism by hand whenever it is found to be sticking.

c. When first used with servohydraulic testing machines the Load Program Modules were found to be particularly sensitive to electrical mains noise. To overcome this problem very careful attention must be given to the coupling between programmer and machine electronics to avoid earth loops, and to provide adequate isolation.

d. Electrical noise can also be a problem in load controllers when very high gains are used in feedback and monitor amplifiers in an attempt to use large capacity load cells on tests requiring only small maximum loads. If troubles of this nature are to be avoided the "one-third" rule (section 3.16b) should be strictly observed. Where higher gains cannot be avoided the operators must be prepared to instal additional shielding and filtering.

e. Before selecting a load sequence disk for a fatigue test the operator must be aware of the direction of the major load excursions of the sequence. This is particularly true of those sequences based upon FALSTAFF where-in the major loads may be all tensile or all compressive. Clearly the operator should not attempt to test long thin specimens using a load sequence with predominantly compressive loads.

7. REFERENCES

1. I. Powlesland and E.S. Moody. The Single Channel Test Controller. ARL-STR-TM (in publication).

2. C.J. Ludowyk. Operators Manual for ARL Servo-amplifier. ARL-STR-TM-407, April 1985.

APPENDIX 1

DISKETTE HANDLING, USE, LABELING & STORAGE INFORMATION

Handling

- Do not clean or touch exposed recording surface.
- Do not smoke while handling the diskette.
- Do not bend or apply paper clips to jacket edges.

Use

- Insert diskette squarely into disk drive, bottom first, with the label side up.
- Return diskette to envelope when removed from drive.

Labeling

- Label information must be written upon label before adhering to jacket. Writing pressure from pen or pencil on jacket may cause disk damage. To minimize contamination, only felt tipped pens should be used to write on labels.
- Labels should be adhered so that their location will not obstruct the index sensing hole or release from the diskette jacket.

Storage

- Do not expose diskette to extreme heat, direct sunlight or magnetic fields.
- Disk required for immediate use should be stored at same temperature/humidity as system operating environment.
- Long term storage should be in the original shipping carton laid on its side to prevent damage from disk sag and compressive forces.
- Storage Environment: Temp 50°F (10°C) to 125°F (52°C)

  Relative Humidity 8 to 80%

  Maximum Wet Bulb 85°F (30°C)

APPENDIX II

LOCATION OF VARIABLES, CONSTANTS AND PORTS

Note: All values are in Hexadecimal notation.

1010	Program Counter
1022	Flight Counter
1034	Turning Point Counter
1014	Disk Error Counter

1000	1111	Ram Check Word	
1002	2222	Ram Check Word	
1004	4444	Ram Check Word	
1006	8888	Ram Check Word	
1008	7FFF	Timer Word	
100A	3F-2FF	Speed Word	(zero crossing)
100C	3F-2FF	Speed Word	(non zero crossing)
100E	3F-2FF	Speed Word	(delay when null not used)
103C	000C	Timer Word	

8010	DAC
1B	Cal. Ø
1C	Cal. 1
1D	Cal. 2
1E	Cal. 3

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14. Descriptions

Data acquisition
Controllers
Servomechanisms

15. COSATI Group

14020

16. Abstract

Information pertinent to the proper operation of the programmers, controllers and data acquisition modules of this instrumentation family, developed specifically for the durability testing of material coupons and aircraft components, is given. The software commands available for system testing, and the procedures for setting and monitoring applied loads are included.

This paper is to be used to record information which is required by the Establishment for its own use but which will not be added to the DISTIS data base unless specifically requested.

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